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MEMC 99-1250/2441.1
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of Hariprasad Sreedharamurthy et al. Art Unit 1765
Serial No. 10/039,459
Filed November 7, 2001
Confirmation No. 1061
For APPARATUS AND PROCESS FOR THE PREPARATION OF LOW-IRON SINGLE CRYSTAL SILICON SUBSTANTIALLY FREE OF AGGLOMERATED INTRINSIC POINT DEFECTS

October 20, 2003

TO THE COMMISSIONER FOR PATENTS,

SIR:

LETTER TO THE PATENT AND TRADEMARK OFFICE

This letter is in response to the Office action mailed May 21, 2003.

Nonobviousness of the Claims 1-14

Reconsideration is respectfully requested of the rejection of claims 1-14 as being unpatentable, at least in part, over Holder et al.

Claim 1 is directed to a crystal pulling apparatus for producing a silicon single crystal grown by the Czochralski process. The structural component comprises a substrate and a protective layer covering the surface of the substrate inside the growth chamber. The substrate comprises graphite and has a concentration of iron no greater than about $1.5*10^{12}$ atoms/cm^3. The protective layer comprises silicon carbide and has a concentration of iron no greater than about $1.0*10^{12}$ atoms/cm^3.

Holder et al. disclose a graphite structural component which has less than about 20 ppm total metals, and preferably less than about 5 ppm metals. Applicants' requirement of no more than about $1.5*10^{12}$ atoms/cm^3 of iron is more than 10,000 times lower than 5 ppm. Additionally, Holder et al. disclose that the protective layer which comprises between about 99.9% to about 99.99% silicon carbide and between about 0.01% to about 0.1% silicon typically comprises about 1 ppma of iron.[1]

[1]Holder et al. at page 3, lines 18-20; page 10, lines 25-33.

Accordingly, Holder et al. fail to disclose or suggest these affirmative requirements of applicants' claims.

Moreover, the proposition stated in the Office action that "purifying an old product is held to be obvious" under MPEP 2144.04 VII does not render these claim requirements obvious. This section of the MPEP specifically acknowledges that "purer forms of known products may be patentable," and directs the Office to consider the following factors to assess patentability:

1) whether the claimed composition has the same utility as closely related materials in the prior art,
2) whether the prior art suggests the claimed form, and
3) whether the prior art suggests methods of obtaining the claimed form.

In the present case, these factors all support a finding that the claimed subject matter is not obvious. With regard to the first factor, the crystal pulling apparatus of claim 1 has a different utility than a crystal pulling apparatus disclosed by Holder et al. According to Court of Customs and Patent Appeals in *In re Cofer*, cited in the MPEP, ". . . whether a given chemical compound or composition has the same usefulness as closely related materials may be an important consideration in determining obviousness under 35 U.S.C. 103."[2] Specifically, the crystal growing apparatus of claim 1 is used to produce a single crystal silicon ingot and wafers sliced therefrom that are substantially free of agglomerated defects and have a low degree of edge iron contamination (e.g., an apparatus comprising six low-iron structural components can produce silicon having an edge iron concentration that is less than about 5 parts per trillion atomic (ppta) and an average iron concentration that is less than about 3 ppta).[3] Such silicon is produced, in part, by decreasing the cooling rate of the growing ingot and maintaining

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[2]*In re Cofer*, 148 USPQ 268, 271 (CCPA 1966). See also *In re Bergstrom* 166 USPQ 256, 262 (CCPA 1970) ("Whether the claimed pure materials have the same usefulness or assortment of properties as the impure materials of the prior art . . . is but one of the factors to be considered in determining the obviousness under 35 U.S.C. § 103.").

[3]Application at page 13, lines 5-13.

the ingot at temperatures that keep intrinsic point defects mobile for longer periods of time. This is accomplished, in part, by designing the apparatus to have a closed hot zone which contains more structural components than an open hot zone. The additional structural components insulate the ingot thereby decreasing heat loss from the ingot. The structural components, when growing silicon substantially free of agglomerated defects, are maintained at high temperatures for relatively long periods of time and this increases the propensity for iron to contaminate the ingot. In contrast to the claimed apparatus, a crystal pulling apparatus made of conventional structural components cannot produce ingots that are substantially free of agglomerated defects without contaminating the silicon with an unacceptable amount of iron (e.g., that silicon will have average iron concentration of 5-10 ppta and an edge iron concentration as high as 100 ppta).[4] In view of the fact that the crystal pulling apparatus of claim 1 produces silicon that is fundamentally and qualitatively different from silicon produced using a crystal puller made of conventional structural components, the crystal puller of claim 1 has a different utility than that disclosed by Holder et al. and the other cited art. This different utility supports a conclusion that claim 1 is nonobvious under 35 U.S.C. 103.

With regard to the second factor, Holder et al. do not recognize the desirability of making a growth chamber of structural components having a substantially lower concentration of iron impurity, much less than 10,000 times the lower concentration. Although Holder et al. disclose particle generation depends on graphite purity,[5] this characterization of conventional graphite cannot be fairly interpreted as a recognition or suggestion to reduce the concentration of metal contaminants to unconventional levels, such as less than about $1.5*10^{12}$ atoms/cm^3. In fact, rather than suggesting a significant reduction in impurities, the entire specification of Holder et al. is directed to controlling iron contamination of a silicon ingot by gettering or capturing metal impurities evolved from structural components.[6] Specifically, Holder et al. disclose two methods

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[4]Application at page 6, lines 23-26.

[5]Holder et al. at page 7, lines 16-18.

[6]Holder et al. at page 4, lines 1-5; page 6, lines 15-22.

of gettering metal impurities such as iron by utilizing the high affinity of silicon for such contaminants. The first embodiment comprises overlaying a silicon carbide or glassy carbon protective layer with a silicon layer.[7] The second embodiment comprises incorporating silicon with silicon carbide in a single protective coating.[8] As described above, the treatment of iron concentrations in the graphite and silicon carbide disclosed by Holder et al. is largely superficial and is consistent with their solution of controlling iron contamination of the ingot by gettering. Thus, Holder et al. do not recognize or suggest the high degree of purity for the carbon substrate and protective layer as required by claim 1.

With regard to the third factor, Holder et al. do not disclose any method for producing a structural component comprising a graphite substrate and a silicon carbide coating having the claimed iron concentrations. For example, claim 1 specifies that the graphite component has a concentration of iron that is no greater than about $1.5*10^{12}$ atoms/cm^3. This concentration is over 10,000 times lower than the 5 ppm concentration of conventional graphite. However, Holder et al. do not provide any direction as to the manner in which such an increase in graphite purity could be attained. Furthermore, the other cited references (i.e., Falster et al., Kim et al., and Luter et al.) fail to mention the possibility of iron in a silicon ingot or the structural components of a crystal growth apparatus. Thus, these references cannot be said to teach or suggest purifying the substrate and protective layer below the conventional levels disclosed by Holder et al.

In *Ex parte Stern*[9], cited in MPEP 2144.04, the Board held the claimed homogenous (purified) human interleukin 2 to be obvious on the basis of conclusions analogous to the factors recited in the MPEP:

> 2) The Office provided evidence the product itself was disclosed or suggested in the art: "Skilled workers in this particular art have sought to purify IL-2 to homogeneity and apparently failed." "...there is a recognition in the art of the desirability of purifying IL-2 to homogeneity." 13 USPQ2d 1381.

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[7]Holder et al. at page 6, lines 8-15; and page 7, line 19 to page 8, line 6.

[8]Holder et al. at page 6, lines 8-15; and page 10, lines 15-24.

[9]13 USPQ2d 1379 (BPAI 1989).

> 3) The Office presented evidence of prior art methods to make the claimed product: "Pestka discloses a process employing high performance liquid chromatography capable of purifying to homogeneity proteins exhibiting molecular weights in excess of 12,000." 13 USPQ2d 1381.

And with regard to the first factor, though not specifically discussed, apparently the applicant failed to present evidence of any special utility beyond that of conventional IL-2. In the present situation, in contrast to the *Stern* situation, a) there is no evidence of record of any suggestion in the prior art of the presently claimed structure, b) there is no evidence of record of any suggestion in the prior art of how to make the claimed structure, and c) applicants specification explains in detail the unexpected advantage the invention provides of facilitating production of wafers that are substantially free of agglomerated defects and have a low degree of edge iron contamination. Accordingly, contrasting the facts of the *Stern* case to the facts of the present application underscores that applicants' claimed invention cannot fairly be deemed to be obvious as a "mere purification."

Further guidance is provided by the decision in *In re Cofer* , cited in the MPEP. The CCPA reversed the Board's finding of obviousness because even though there was evidence of factor 1) common utility, there was no evidence of factor 2) suggestion in the art to make the enhanced compound, or factor 3) suggestion on how to make the enhanced compound. Similarly, in the present case the Office has not pointed to any 2) suggestion in the prior art to make the claimed enhanced structure, nor to any 3) suggestion in the prior art how to make the claimed enhanced structure. The present claims are therefore allowable for the same reasons as the claims in the *Cofer* decision cited in the MPEP.

With regard to the *Ex parte Gray* case cited in the Office action and in the MPEP, applicants do not contest the proposition that "mere purity of a product by itself does not render the product unobvious." But in the present case, patentability is premised neither on the basis of "mere purity," nor on purity "by itself." The specific requirements of the claims with regard to purity, as described in detail above, facilitate production of wafers that are substantially free of agglomerated defects and have a low degree of edge iron contamination. This is an unexpected advantage, namely, an

entirely distinct realm of capacity not available with structures having only conventional purity. Moreover, the purity level required in applicants' claims cannot fairly be deemed to be "mere," as neither the level itself nor a method of achieving it is suggested in the art.

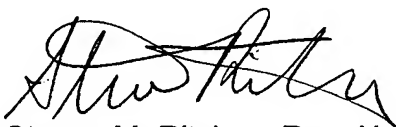
In view of the foregoing, the Office has failed to present a *prima facie* case of obviousness because the cited art fails to disclose, teach, or suggest the desirability of, nor a method for making, a crystal pulling apparatus comprising a structural component that comprises a graphite substrate having a concentration of iron no greater than about $1.5*10^{12}$ atoms/cm^3 and a protective layer that comprises silicon carbide and has a concentration of iron no greater than about $1.0*10^{12}$ atoms/cm^3. As such, claim 1 is submitted as patentable over Holder et al, Falster et al., Kim et al., Luter et al., or a combination thereof.

Additionally, claims 2-14 which depend directly or indirectly from claim 1, are also submitted as patentable for the same reasons as set forth above and in view of the additional requirements which they specify.

Favorable consideration and allowance of claims 1-14 is respectfully requested.

A check for $420.00 is enclosed for the two-month extension fee. The Commissioner is hereby authorized to charge any additional fees which may be required to Deposit Account No. 19-1345.

Respectfully submitted,



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